

REMARKS

Claims 1 to 3 are under consideration in the application. Claims 4 to 7 have been withdrawn from consideration due to the restriction requirement.

§102/§103

Claims 1 to 3 were rejected under 35 U.S.C. §102(b) as being anticipated by Japan No. 2000-290730 to Suzuki et al.

Claim 3 was rejected under 35 U.S.C. §103(a) as being unpatentable over Japan No. 2000-290730 to Suzuki et al. in view of Japan No. 2003-005751 to Fujita et al.

These rejections are respectfully traversed.

Patentability

Japan No. 2000-290730 (“JP ‘730”)

The product obtained by the present invention is different from the product obtained by JP ‘730 because of the difference in the production process.

A big difference is that JP ‘730 does not have the feature of “an average diameter of the particle size of the oxide is 0.01 - 1 μm ” which is an important feature of the present invention.

The production process disclosed in JP ‘730 is: hot rolling → removing mill scale (black scale) → cold rolling → CAL (annealing in the specified atmosphere defined in Formula 1) → pickling → CGL (annealing in a reducing furnace in the specified atmosphere defined in Formula 2) → galvanizing in a zinc bath.

On the other hand, the production process defined in the present invention is: hot rolling → cold rolling → CGL (annealing in the specified atmosphere defined in claim 7) → galvanizing in a zinc bath → galvannealing.

(1). In JP '730 the fine inner oxide layer having several microns after CAL is formed only within the range of Formula 1. Otherwise, the inner oxide layer does not fine in JP '730 in the case of being outside the range of Formula 1. (JP '730 [0007]).

This inner oxide oxide layer of JP '730 improves platability in CGL because the inner oxide layer is formed during the heating step because of the high oxygen potential, and this inner oxide layer remains just before the plating step, and prevents a dispersion of dissolved Si and Mn existing in the steel sheet to the steel sheet surface. As a result, surface concentration is restrained and platability is improved. (JP '730 [0018]).

(2). Surface concentrates containing Si and Mn are removed in JP '730 by pickling. (JP '730 [0042]).

(3). CGL annealing atmosphere: It is desirable in JP '730 that the CGL annealing atmosphere is a sufficient reduction atmosphere for securing platability by means of reduction of the oxide film formed on the steel sheet surface after pickling. (JP '730 [0047]).

That is: the inner oxide layer of JP '730 formed in (1) is grown by absorption of Si, Mn dispersed from the inside of the steel sheet when restrained by a dispersion of dissolved Si and Mn existing in the inside of the steel sheet going to the steel sheet surface layer during CGL annealing, which is called "Ostwald growth".

The oxide particles having a particle diameter of more than 0.01 μm and less than 1 μm , as defined in the present invention, are very energetically unstable under the condition of a fine inner oxide layer having several microns being formed, even if the inner oxide layer is formed, and then such oxide particles disappear during Ostwald growth of the inner oxide layer.

As mentioned above, JP '730 aims to remove dissolved Si and dissolved Mn remaining in the surface layer by pickling. In addition, the CGL atmosphere is fixed for a

sufficient reduction atmosphere defined in formula (2). Therefore, oxide particles are not newly formed in the inner oxide layer formed during CAL. The inner oxide layer formed during CAL is grown by absorption of Si, Mn dispersed from the inside of the steel sheet when restraining a dispersion of dissolved Si and Mn existing in the inside of the steel sheet going to the steel sheet surface layer during CGL annealing.

The oxide particles having a particle diameter of more than 0.01 μm and less than 1 μm , as defined in the present invention, are very energetically unstable under the condition of a fine inner oxide layer having several microns being formed, even if the inner oxide layer is formed, and then such oxide particles disappear during Ostwald growth of the inner oxide layer.

On the other hand, according to the present invention, oxide particles having a diameter of more than 0.01 μm and less than 1 μm are formed on the steel sheet surface in CGL, and these oxide particles move to plated layer. Then Fe-Zn alloying is promoted by means of reaction of these oxide particles contained in the plated layer. In JP '730, there is no formation of oxide particles having a diameter of more than 0.01 μm and less than 1 μm on the steel sheet surface. There is no movement of the inner oxide layer.

It is clear that the inner oxide layer formed by CAL in JP '730 does not move to plated layer by the following Applicant's experiment.

The present inventors conducted an experiment under the same conditions of JP '730 and obtained the plated steel sheet and observed the structure at the cross-sectional area of the plated steel sheet.

(1). The steel sheet contains Si: 1.2 mass %, Mn: 1.6 mass %.

(2) Annealing atmosphere: $\text{H}_2\text{O}/\text{H}_2$: 0.1, H_2 : 5%, N_2 : 95%, annealing at 800°C for 60 seconds.

(This experimental condition is the same condition shown in Fig. 2 of JP '730).

(3). Pickling is not done because this experiment is carried out in a laboratory.

(4). Then annealing is carried under the following conditions.

Atmosphere: $\text{H}_2\text{O}/\text{H}_2$: 2×10^{-3} , H_2 : 5%, N_2 : 95%, annealing at 800°C for 60 seconds → cooling to 470°C → galvanizing → heating at 450°C for 60 seconds → alloying treatment.

(This experimental condition is the same condition shown in the Fig. 3 of JP '730).

(5). The cross-sectional area including the plating layer is polished and Si distribution is observed by EPMA.

As shown in Fig. 1 attached hereto, although the inner oxide layer is formed on the surface of the steel sheet, oxide particles are not found in the plating layer.

Further, the inner oxide layer is formed as a film state having several microns thickness. The present inventors confirmed that oxide particles are not taken into the plating layer during alloying treatment because the zinc dispersion is prevented by the inner oxide layer.

It is therefore submitted that independent claim 1, and claims 2 and 3 dependent thereon, are patentable over Japan No. 2000-290730.

Japan No. 2000 - 005751 ("JP '751")

The technology disclosed in the JP '751 relates to a high strength, hot dip galvanized steel sheet having excellent plating adhesion at high working and excellent ductility.

The JP '751 discloses that Mn is an easier formed oxide film than Al which is added to the Zn bath, and increases reaction which the Si system oxide film formed on the steel sheet surface. (JP '751 [0017]).

This means that the Si system oxide film in JP '751 is formed on the steel sheet surface before plating. On the other hand, according to the present invention, although oxide particles having a diameter of more than 0.01 μm and less than 1 μm exist underneath up to 1 μm of the steel sheet, there is no Si system oxide film is formed on the steel sheet surface.

Further, the steel sheet of JP '751 is annealed at a temperature calculated from the A_{c1} and A_{c3} points in an atmosphere composed of 10% H_2 - N_2 . This means that the steel sheet is retained in 10% H_2 - N_2 atmosphere. (JP '751 [0065]). On the other hand, according to the present invention, steam is introduced to N_2 gas with 10% of H_2 gas, and the amount of steam is controlled and further there is control of the ratio of $\text{PH}_2\text{O}/\text{PH}_2$. The annealing atmosphere of the JP '751 is quite similar to the Processing condition of Comparative Examples Nos. 2, 5, 6 and 8 in Table 2 at page 17 of the present specification.

The Test Material Code and Treatment Condition Nos. NA-5, NA-8, A-5, A-8, B-2, B-5, B-6, C-2, C-5, C-6, D-5, D-6, E-5 and E-6 in the Comparative Examples in Table 3 at page 19 of the specification of the present application correspond to the Processing condition Nos. 2, 5, 6 and 8 in Table 2.

In these examples, ND is marked because it is impossible to detect the oxide particles in the plating layer. This means that there is no oxide particles in the plating layer in Comparative Examples similar to the JP '751.

JP '751 clearly discloses that the result of JP '751 can be obtained by an appropriate amount of Mn in the plating bath, and Mn is an easier formed oxide film than Al which is added to the Zn bath, and increases reaction with Si system oxide film formed on the

steel sheet surface for preventing plating defects. (JP '751 [0017])). This is quite different from the characteristic features of the present invention.

It is therefore submitted that claim 3 is patentable over Japan No. 2000-29730 in view of Japan No. 2000-005751.


CONCLUSION

It is submitted that in view of the foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application be allowed and passed to issue.

If claim 1 is found allowable, it is respectfully requested that withdrawn, non-elected dependent claims 4 to 7 be rejoined to the application.

Respectfully submitted,

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